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LB-Based Simulation of Deformable Capsules, Particles and Fibers with Sharp Fluid-Solid Interface.

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The lattice-Boltzmann (LB) based DNS of rigid particles in fluid is now widely applied to suspension flows. With my students, J. Clausen, R. MacMeccan, and J. Wu, we have extended the original LB method for *impermeable* rigid particles suspended in liquid (Aidun, et al., J. Stat. Phys. 1995, and JFM 1998) to include capsules with deformable membrane, deformable particles and fibers. For capsules with deformable membrane, the combination of the LB method for the fluid phase with finite element (FE) discretization of the solid membrane has shown to be most effective. I will also present a new solid-fluid coupling method for LB simulation of moving particles developed with my student, J. Wu, that is superior to the regular 'bounce-back' method. The LB equation for the fluid is solved on a fixed lattice where the particles are fitted into a Lagrangian grid with sharp fluid-solid interface (IG) eliminating the inherent sudden movement/deformation of the interface from node to node through the lattice. For example, we apply this method to couple the LB with the lattice-Spring method. Compared to the regular "bounce-back", we will show that this method is more stable and smooth. I will present the effect of particle deformation on rheology of spheres, red blood cells, and fibers to demonstrate that these methods open the possibility for analysis of a class of deformable particle/fiber suspension rheology and microstructure.